REMARKS

Favorable reconsideration of this application as presently amended and light of the following discussion is respectfully requested.

Claims 1-13 and 15-19 are presently active in this case, Claims 9-12 and 15-16 amended, Claim 14 canceled and Claims 17-19 added by way of the present amendment.

Applicants first note that Claims 9-13 and 15-16 have been amended to correct minor informalities and to clarify that these claims are not means plus function claims to be interpreted under 35 U.S.C. § 112, sixth paragraph. Further, Claims 17-19 have been added as claims corresponding to pending Claims 9, 11 and 12 respectively, but written in means plus function format.

Turning now to the merits, in order to expedite issuance of a patent in this case, Applicants have amended Claim 9 to clarify the patentable features of the present invention over the cited references. Specifically, Applicants' Claim 9 recites a status monitoring apparatus for monitoring an operating status of a plasma processing apparatus and/or a processing status of an object being processed, based on a result of analyzing light emitted from a plasma generated while the plasma processing apparatus performs a plasma process on the object in a processing chamber. The status monitoring apparatus includes a unit configured to obtain an emission spectrum emitted from the plasma when the plasma process is performed on the object, and a unit configured to obtain quantitative data for each of a plurality of emission sources from the obtained emission spectrum by using reference data in a database storing therein an emission spectrum for each of the emission sources as the reference data. The unit for obtaining the quantitative data determines an inner product value between the emission spectrum obtained by the plasma process and the reference data, and sets the inner product value as the quantitative data. Also recited is a unit configured to estimate the operating status of the plasma processing apparatus and/or the processing status

of the object being processed, based on changes in the quantitative data for each of the emission sources.

As discussed in the Background section of Applicants' specification, because a conventional plasma processing apparatus detects intensities of only two wavelengths of the activated species of process gas, the reaction products do not provide sufficient accuracy for detecting the processing status. However, in accordance with the present invention, since reference data stored in the data base including an emission spectrum for each of emission sources is used to obtain quantitative data for detection, it is possible to perform monitoring based on data of wider wavelength range compared with a case merely using data of specific wavelengths. Therefore, where semiconductor devices require finer processing performance, the processing status of the plasma processing apparatus can be more simply and accurately monitored by merely monitoring changes in the inner product values, thereby improving the accuracy of monitoring the operating and processing status of the plasma processing apparatus.

Further, regarding the claimed database, since the set of emission spectra are separated into the emission spectrum for each of the emission sources, the database can be created without being affected by noise even if the noise is mixed in a set of emission spectra. Still further, since the processing status of the plasma processing apparatus is estimated by using the quantitative data for each of the emission sources, which is determined on the basis of the emission spectra (reference data) stored in a database after obtaining the emission spectrum emitted from the plasma during the plasma process, the operating state of the plasma processing apparatus and the processing state of the object are processed in real time.

In contrast, Angell only discloses a method of selecting a wavelength of light to monitor for end-point detection during etching. As clearly shown in Figs 3 and 4, spectral data is collected during etching and a principal component of the data is calculated. Each

principal component has variables which correspond to wavelengths of the light, each variable having a weight. By analyzing the weights, it is determined which variable of the principal component varies during the etching such that end-point of the etching can be detected by monitoring the wavelength corresponding to the variable.[1] Further, calculating the principal component of the data performs no more than the first four principal components since there is little probability to satisfy the end-point control purposes if exceeding the first four principal components.

Thus, Angell only suggests a method for optimizing selection of a wavelength to monitor for end-point detection during etching. As a result, Angell merely monitors specific wavelengths in the same way as the Background prior art which Applicants' invention is intended to improve upon. In this regard, Applicants acknowledge that the Office Action pointed out that reference data (weights) of Angell are obtained by principal component analysis of the stored data in advance to identify a channel which varies. However, weights of the variables of each principal component are obtained by calculating a principal component of the input data collected during etching for monitoring end-point detection. In other words, weights are not emission spectra, and are irrelevant with the reference data in the database storing therein the emission spectrum for each of the emission sources in the present invention.

Finally, Applicants note that an object of Angell is to satisfy a need for optimizing selection of a wave length to monitor for end-point detection during etching.[2] On the contrary, as noted above, an object of the present invention is to provide the sufficient accuracy of detecting the processing status on the basis of data of wider wavelengths compared with a case merely using data of specific wavelengths.

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[1] See Angell at column 2, lines 56-68.
[2] Angell at column 2, lines 50-52.

Consequently, the subject matters in amended claim 9 are totally different from the disclosures of Angell. Since Angell does not suggest nor teach anything on detecting the processing status based on quantitative data of wider wavelengths in accordance with the present invention. The cited reference to Balasubramhanya is also directed to a method and an apparatus for monitoring a process by employing principal component analysis. By taking the inner product of a production principal component (e.g., same order principal component as a calibration principal component) and the calibration principal component, the production principal component is compared to the calibration principal component for deciding whether both of them are the same or not. Further, if they are determined not to match, a new production principal component is compared to the calibration principal component repeatedly until either the desired process state, process event or chamber state is found. Thus, in accordance with Balasubramhanya, the inner product is determined only between principal components which associate certain wavelengths with particular species specific wavelengths. In contrast, in accordance with the present invention, the inner product values are determined between the emission spectrum itself emitted from the plasma without performing a principal component analysis and the reference data in the database storing therein an emission spectrum for each of the emission sources as the reference data.

Consequently, since the inner product only between a production principal component and the same order calibration principal component is calculated to find whether they are matched or not, Balasubramhanya merely monitors specific wavelengths which are associated with certain principal component. Thus, Balasubramhanya can not provide the sufficient accuracy of detecting the processing status, unlike the present invention.

Therefore, the disclosure of Balasubramhanya are also totally different from the subject matter in amended claim 9; and teach just the inner product between principal

components. Further, Balasubramhanya does not contain the necessary motivation or some suggestion to modify Angell to arrive at the claimed invention.

Accordingly, Angell or Balasubramhanya et al. does not disclose nor suggest a plasma processing apparatus for monitoring an operating status of a plasma processing apparatus and/or a processing status of an object being processed in the basis of changes in the quantitative data for each of the emission sources by determining an inner product value as the quantitative data between the emission spectrum by the plasma process and reference data of each of the emission sources stored in the database as required by claim 9. Therefore, claim 9 patentably defines over Angell and Balasubramhanya. Further, means plus function claim 17 patentably defines over these references for similar reasons.

It is also believed that claims 10, 13, 15 and 16 are allowable for the same reasons indicated with respect to the amended claim 9 and further because of the additional features recited therein which, when taken alone and/or in combination with the features recited in the amended claim 9, remove the invention defined therein further from the disclosures made in the cited references.

The basic requirements of a *prima facie* case of obviousness are set forth in the MPEP §2143. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine the reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, not in Applicants' disclosure. In re Vaeck, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). Further, MPEP §2143.03 states that all claim limitations must be taught or suggested by the prior art. In re Royka, 490 F.2d 981, 180 USPQ 580 (CCPA 1974). "All

words in a claim must be considered in judging the patentability of that claim against the prior art." In re Wilson, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970). If an independent claim is non-obvious under 35 U.S.C. 103, then any claim depending therefrom is non-obvious. In re Fine, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988).

Applicants submit that a *prima facie* case of obviousness of the amended claims cannot be established. In particular, the present invention, as defined in claim 10, is directed to the plasma processing apparatus, wherein the database is created in advance by a unit for obtaining a set of emission spectra, each emission spectrum of the set being emitted from a plasma during each plasma process performed under various process conditions; and a unit for separating the set of emission spectra into the emission spectrum for each of the emission sources by a multivariate analysis and storing the separated emission spectrum as the reference data. Further, in accordance with the present invention defined in claim 11, the multivariate analysis is an independent component analysis, and the emission spectrum for each of the emission sources corresponds to an independent component obtained by the independent component analysis. By using the independent component analysis to separate the set of emission spectra into the emission spectrum for each of the emission sources, the effects of the noise can be more effectively removed.

As stated above, Angell and Balasubramhanya fail to disclose a plasma processing apparatus for monitoring an operating status of plasma processing apparatus and/or a processing status of an object being processed on the basis of wider wavelengths to provide the sufficient accuracy of detecting the processing status in accordance with the present invention. Further, the secondary reference Christopher Webber only provides a signal processing technique i.e. independent component analysis; and further does not contain the necessary suggestion, teaching or motivation to modify the prior arts to arrive at the claimed invention. Accordingly, applicants most respectfully submit that additional teachings of

Christopher Webber do not overcome the deficiencies of the primary references as discussed above and the rejections should be withdrawn.

Consequently, in view of the present amendment, no further issues are believed to be outstanding in the present application and the present application is believed to be in condition for formal allowance. An early and favorable action is therefore respectfully requested.

Respectfully submitted,

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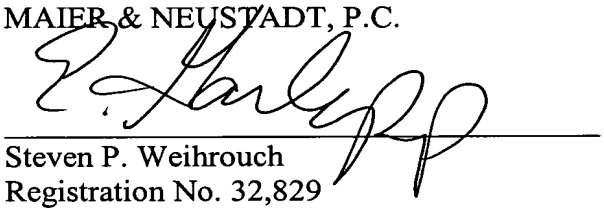

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